A LARGE SPIRAL STRUCTURE FROM THE CRETACEOUS BEDS OF WESTERN QUEENSLAND.

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(Plate XXXII; Text-figures 1–4).

Explanation.—Mr. J. K. Ellis of Blackall recently forwarded to the Queensland Museum several portions of a large spiral object found by Mr. C. Catchlove and himself at a locality 8 miles north of Duthie Park homestead and about 25 miles east-north-east of Blackall. With it was sent a group of associated nodules. All these objects are now lodged in the collections of the Museum.

Description.—The spiral object, illustrated on Plate XXXII, figs. 1*a*, 1*b*, is not complete. When the several portions of it are put together a gap is noticed (indicated by a dotted line on the figure) where a section representing one or more whorls is missing.

The specimen, to this extent incomplete, is 203 centimetres long. The maximum width is 22·5 cms.

In form it is a dextral, helicoid spiral with 25 whorls preserved. The individual whorls are in contact and impressed at their junctions but they do not overlap. The whorls are approximately circular in cross-section except the end members in which a flattening takes place, while the external surface of each whorl is arched convexly. On the average the diameter of each whorl is approximately four times its length.

A very slight curvature is developed on what has been determined as the horizontal plane of the specimen.

At one end (the right-hand end in the figures on Plate XXXII) the final whorl is pillow-shaped, relatively large, and with its axis oblique to the maximum length of the specimen. The transverse diameter of each succeeding whorl is approximately normal to the general length. There is a noticeable decrease in the size of the whorls towards the middle of the specimen, after which a progressive increase in size takes place. At the opposite end the final whorl is unfortunately incomplete and abuts upon a mass of nodular structures. The seven whorls adjacent to this end have, on what would appear to be the lower surface, a shallow, transverse, median depression that is shown on Plate XXXII, fig. 1*a*.

Dimensions.—The following measurements were made upon the specimen. There is of course a variation in each individual whorl. The figures for the length of each whorl were obtained by measurements along a line at about the middle of the lower surface. The measurements of the diameters of the whorls were made at right angles to the line. Whorl No. 1 is that shown at the right-hand side of the figure.

	Length of Whorl. (in cms.)	Diameter of Whorl. (in cms.)
1	15·8	..
2	9·5	22·5
3	9·2	20·7
4	8·5	17·0
5	6·4	18·1
6	8·3	18·1
7	7·7	18·0
8	6·3	16·8
9	7·5	16·1
10	5·6	16·2
11	7·5	17·0
12	7·0	16·0
13	5·4	16·6
14	7·4	17·2
15	4·9	18·4
16	8·1	19·9
Break	~~~	~~~
17	..	..
18	8·2	18·8
19	6·9	18·6
20	7·8	19·8
21	6·0	18·5
22	8·4	20·8
23	6·8	19·6
24	7·8	..
25	8·8	21·2

Composition.—Microslides have been made of the substance from each end and from about the middle of the specimen. These all agree in being a brown, calcareous sandstone with fontainebleau structure, and with the grains small in size, angular and composed mainly of quartz but with some fresh felspar fragments present. A certain amount of argillaceous matter is present also. This is one of the commonest rock types in the beds of the Great Artesian Basin.

Occurrence.—Along two opposite faces the specimen shows a slight grooving. On one side of this the surface is washed clear of extraneous matter. On the other side of the grooving the surface is covered with a structureless, white, calcareous substance identical with the precipitated lime deposits in the normal pedocalcic soils of this region. This suggests that the specimen has been embedded in the ground or in the rock up to the level of the grooving, the coated portion being thus the lower part. This pulverulant lime coating has nothing to do with shell substance; and it may be pointed out that nowhere on the surface of the whorls or in the impressed zone between them is there any trace of shelly calcareous matter.

The grooving is at an angle of 7° to the general length of the specimen. On Plate XXXII, fig. 1*b* the line of junction of the two surfaces may be seen starting from the base of the main break in the specimen and running upwards and to the right from that point. In this orientation the upper portion as shown on Plate XXXII, fig 1*b* was the embedded side.

The Cretaceous beds of Western Queensland outcrop over vast areas of plains and dip at only very gentle angles. This angle of 7° on the specimen suggests that it was contained in the rocks lying along, or else at a very slight angle to the bedding plane.

Associated Structures.—Accompanying the specimen were masses of closely packed, flattened, nodule-like structures that Mr. Ellis in his letter appropriately compared to " a batch of buns." These are composed of similar brown, calcareous sandstone of the fontainebleau type. As has been mentioned the whorls at one end of the spiral abut upon a mass of such objects ; but, unfortunately, owing to the specimen being there incomplete, the relationship of the spiral to the associated nodules is not to be determined.

Age.—Duthie Park is near the margin of the Great Artesian Basin in a region where the lowest beds (Roma Series) are overlapped by those of the Tambo Series. In this great basin of Cretaceous deposits the lower beds are of marine origin and are divisible into two series, the lower or Roma Series being of Aptian age and the upper or Tambo Series belonging to the Upper Albian (*see* Whitehouse 1928). Above the Tambo Series lies the Winton Series of non-marine beds and which, from available evidence, has a maximum thickness of at least 4,000 feet. The gradation from the Tambo Series to the Winton Series is complete. The lithology of the two Series is identical, the typical rock types being blue clays with bands of concretionary, calcareous sandstones. It is never possible in the field to place a line dividing the two Series ; for the Tambo Series, so richly fossiliferous in its lower phase is, in its upper beds, almost entirely barren of fossils. Prolonged search in such upper beds of the Tambo Series may bring to light some fragments of *Inoceramus* or an *Aucellina*. With identical lithology in the two Series and a progressive decrease in the abundance of fossils in the lower it is usually impossible to say, in any pertinent area, where the marine Tambo Series ends and where begins the Winton Series, which has yielded plant remains from a few localities but never marine fossils. The work of Mr. C. Ogilvie and myself shows that, as a field guide, there are only two criteria that at present serve to distinguish definitely Tambo from definitely Winton Series beds. The typical concretions of the Tambo series are flattened, oval things (" Damper shaped "), while those of the Winton Series are usually spherical (" Cannon-Ball types "). Also, yellow shale pellets are common in the sandstones of the Winton Series but rare in such beds from the Tambo Series.

There are no fossils in the matrix of these specimens ; but from their geographical position in the basin it would seem that the beds of Duthie Park would be in the upper part of the Tambo Series or in the lower part of the Winton Series and so tentatively may be regarded as being of Cenomanian age.

Comparable Forms.—Three other groups of strange, large, spiral structures are on record. In 1892 Barbour recorded gigantic spiral forms from Miocene beds in Nebraska to which he gave the name *Daimonelix* (later changed to *Daemonhelix* by von Ammon). Similar forms recorded under this name have been found in Pleistocene beds in America (Wood & Wood, 1933) and in the Oligocene of Bavaria (von Ammon, 1900). On these forms there is now a considerable literature that has been summarised recently by Wood & Wood (1933).

In 1922 Woodward described some gigantic spirals, over seven feet in length, from the lower Wealden Beds (Wadhurst Clay) of England and, diagnosing the form as a gastropod, gave to it the generic name *Dinocochlea*.

A recent addition to our knowledge of these weird, giant spirals was made by Cox (1929) who figured a form dredged from the bottom of the North Sea.

In addition to these forms spirals of small size and of puzzling origin are known from many formations, paleozoic, mesozoic, and tertiary. References in literature to many of these have been given by Wood & Wood (1933, p. 830).

Daemonhelix reaches a length of many feet with a width of sometimes one foot. The spiral generally maintains a fairly uniform width. Both dextral and sinistral forms are known. It has a feature unique among such spiral structures, that near the base a long, straight, lateral process is given off from the main structure. Another feature of some interest is that occasionally in these forms an axial, cylindrical process is found.

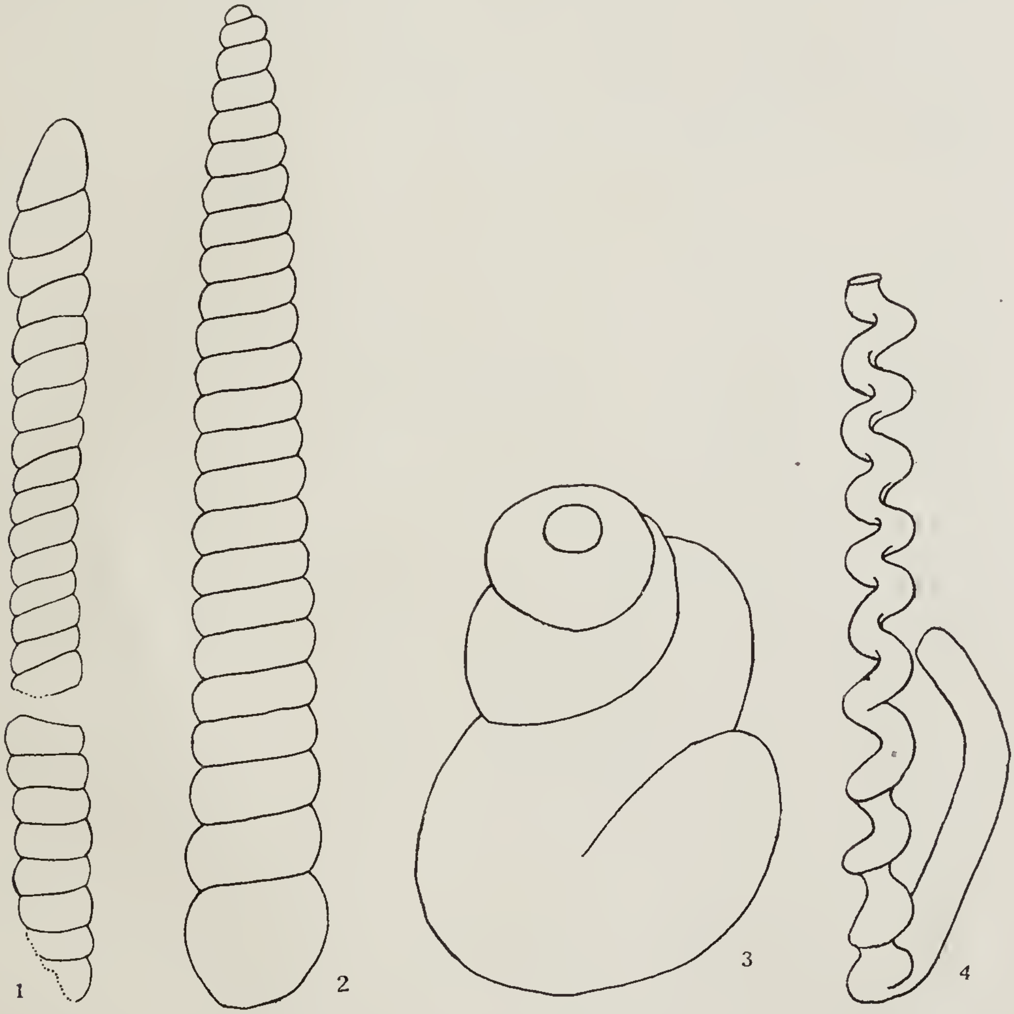
Among the spirals described as *Dinocochlea* both dextral and sinistral forms occur. Starting from a protoconch-like process the spiral slowly increases in width in a most regular manner, the increase corresponding to a logarithmic spiral.* The final whorl is considerably larger than any preceding. The very regular spiral and the appearance of the ends of the specimen temptingly suggest that the form is an internal mould of a gigantic gastropod of undetermined affinities. A coincidence that may be worthy of remark is that this form, like the Queensland specimen, is preserved in a calcareous sandstone with fontainebleau structure.

The mode of occurrence and the age of the North Sea specimen are of course unknown. Like *Dinocochlea* this is in the form of a widening spiral resembling a gastropod. It is, however, a more globular type and with fewer whorls than any of the other forms.

Dinocochlea and the present form agree in that they are embedded more or less in the plane of bedding of the rocks. *Daemonhelix* occurs in both vertical

* In one of these forms (a dextral specimen) Woodward (1922, p. 244) determined the ratio for the logarithmic spiral to be 1·02. For a sinistral form he quotes the ratio of 1·055.

and horizontal position. This new form and *Daemonhelix* are similar in that the spirals retain a general cylindrical shape. The other special features of *Daemonhelix* render more detailed comparison unnecessary. With *Dinocochlea*, however, the resemblances are closest. The two types differ in that the English form has a regularly widening spiral. In length they are comparable. Restored, the most



Text-figures 1–4. The several large Spirals. 1, The Queensland form. 2, The Wealden form (after Woodward). 3, The North Sea form (after Cox). 4, The Nebraska form (after Barbour). Figures one-eighteenth natural size.

complete English specimen has a length of 220 cms. The Queensland form is 203 cms. long but when complete would be somewhat greater than this. In this length of 220 cms. on the English form there are 23 whorls. The Queensland spiral has 25 whorls in a length of 203 cms.

The close comparison that is possible between the Australian and English forms is of particular interest since both are from Cretaceous beds—*Dinocochlea* from the early part of the period and the new form apparently from near the middle.

Origin.—In attempting to explain the origin of such a spiral object it is necessary to summarise and to stress the following points :—

1. The structure is a relatively uniform helicoid spiral with no regular increase or diminution in size of whorls.
2. One end is bulbous suggesting that the structure was closed at that point. Unfortunately, the opposite end is not preserved.
3. No trace of an investing shell is to be found on the surface of the specimen or on the impressed zone between the whorls.
4. The object lay more or less in the plane of bedding in lacustrine or estuarine sediments of Cretaceous age.
5. The material of which it is composed is an arenaceous rock type common to Cretaceous sediments in the Great Artesian Basin.

Considering the great bulk of the specimen. the last of these premises suggests that the structure was formed either by concretionary action within an ordinary rock type or else by the infilling of a spiral cavity existing at the time of deposition of the beds.

The absence of any investing shell is important. In the marine beds of the Great Artesian Basin molluscs and other forms are very well preserved, and even with thin-shelled species it is rare to find an internal mould devoid of some traces of the shell. The fact that over the whole great surface of this spiral and in the impressed zone between the whorls there is no trace of any shell substance, renders improbable a suggestion that the specimen is an internal mould of an organism with a calcareous test.

As possible explanations of similar, large, spiral structures previously described, the following suggestions have been made by various authors :—

(A) An Inorganic Origin—
  1. Infillings of potholes.
  2. Concretions.

(B) An Organic Origin—
  3. Internal moulds of Gastropods.
  4. Coprolites.
  5. Burrows.
  6. Roots.

As Woodward (1922 p. 242) has pointed out for *Dinocochlea* the horizontal position of the specimen makes the suggestion of an infilled pothole untenable.

If it were possible to record a process producing horizontal, spiral structures in a concretionary way such an action would be the most favourable explanation of the origin of this form. Like *Dinocochlea* it occurs in a sedimentary series notably rich in concretions. As mentioned previously the

Winton Series in which it is developed is characterised by spherical concretions. A close, axial development of such spheres could lead to the production of a linear series of impinging, rounded, disc-like forms superficially similar in lateral view to this spiral. But I know of no method in which, by such means, a spiral coiling could be produced.

Woodward's suggestion of an internal mould of a giant gastropod, although capable of explaining the form of *Dinocochlea* and the North Sea specimen, is inadmissible for this spiral. There is no gradual increase in the size of the whorls ; and the free end that is preserved suggests neither the proximal nor the distal end of a gastropod shell. Furthermore, considering the conditions of preservation, the absence of any trace of shell substance is opposed to such a conclusion.

Many coprolites, as Buckland (1835) long ago showed, are spiral things ; and most of the giant spirals now discussed can be compared in superficial form with the small things figured by him. The great size of these spirals has been regarded as militating against such an origin. This is unreasonable ; for both the Wealden and the Queensland spirals occur in beds where giant dinosaurs are known. *Austrosaurus mckillopi*, a dinosaur recently described by Longman from the Tambo Series, was estimated to be of the order of fifty feet in length (Longman, 1933, p. 142). With beasts of such size a coprolite of seven feet in length is possible. Some interest is added to this suggestion by the piled nodular masses associated with the spiral and conceivably of fæcal origin. However, a serious objection to the coprolite theory is that the microslides show the minerals of a normal, arenaceous, sedimentary rock and have no fragments of fish scales or other organic matter—undigested food particles—that might be expected if it were a coprolite. It is possible, of course, and easy to imagine that the substance of a coprolite shortly after being embedded in a loose sediment could be dissolved away and the cavity so produced infilled by arenaceous sedimentary material. But it is difficult to conceive of this happening without some collapse of the walls, particularly on the upper surface ; and the only deformation noticed on the specimen is slight and on what appears to be the lower surface.

Replaced root structures and the infilling of a burrow* are the theories most favoured to explain *Daemonhelix*. Each is capable of explaining the form of the Queensland spiral but neither can be proved. The closed end preserved on the specimen suggests that, if it be an infilled burrow, that end is the underground termination, and the other end should then be open. It is unfortunate that this end is incomplete. For the Wealden and the North Sea spirals, where both ends are preserved, the burrow theory is unlikely. If the Queensland form should be an infilled burrow the question arises what animal with a horizontally burrowing habit could dig the cavity.

* With *Daemonhelix* the burrow has been attributed to some form of rodent.

Two other coincidences may be noted about these spirals generally :—

1. The two forms most similar (the Queensland and the Wealden specimens) are comparable in age ;
2. Excluding the North Sea form the derivation of which is unknown, all these large spirals seem to occur in lacustrine or estuarine beds.

The first of these coincidences may suggest an organic origin—that the two forms are species of the one genus (*Dinocochlea*) of obscure relationships. If so, considering the Queensland evidence, Woodward's suggestion of a gastropod would be untenable. However, with only two occurrences for a problematical structure it would be unwise to stress this point of view

On the second coincidence too it is probable that little weight should be placed ; for the twofold form of *Daemonhelix* (the spiral and the lateral processes) suggests an origin different from that of the other and simpler forms.

Thus the problem of the origin of this spiral cannot be decided on the evidence available. No proffered explanation is free from grave objection, and it would be useless at present to press the claim of any one theory as a valid explanation of such a puzzling form.

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EXPLANATION OF PLATE XXXII.

Figs. 1*a*, 1*b*. Two views of the large spiral structure. (*a*) lower surface ; (*b*) lateral view. The dotted line marks the break from which portion of the specimen is missing.

Figs. 2, 3, 4. Nodular masses associated with the spiral structure.

(Figures are reduced according to the scales shown.)

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